A home-grown innovation for a highly productive future

APM Terminals has designed and developed its own STS crane to eliminate constraints of current designs

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Increasingly large ships require a quantum leap in terminal productivity

Every year the world container ship fleet comprises more and more ultra-large container vessels. Only five short years ago, the number of ships in the world with more than 10,000 TEU capacity was zero; today there are 73, and by 2012 the number will have more than doubled to 180.

Time is money for these large ships, and consistently higher berth productivity through increased crane intensity and greater planning flexibility offers potential to reduce port time for these large ships by up to 50 percent. In many container terminals today, throughput capacity is limited by berth capacity. Provided there is sufficient yard capacity, increasing berth capacity through greater crane productivity or crane intensity enables greater annual terminal throughput.

In late 2006, a cross-functional team of APM Terminals staff were brought together for an innovation brainstorming session, to find ways in which APM Terminals could deliver a quantum leap improvement in service delivery to its customers.

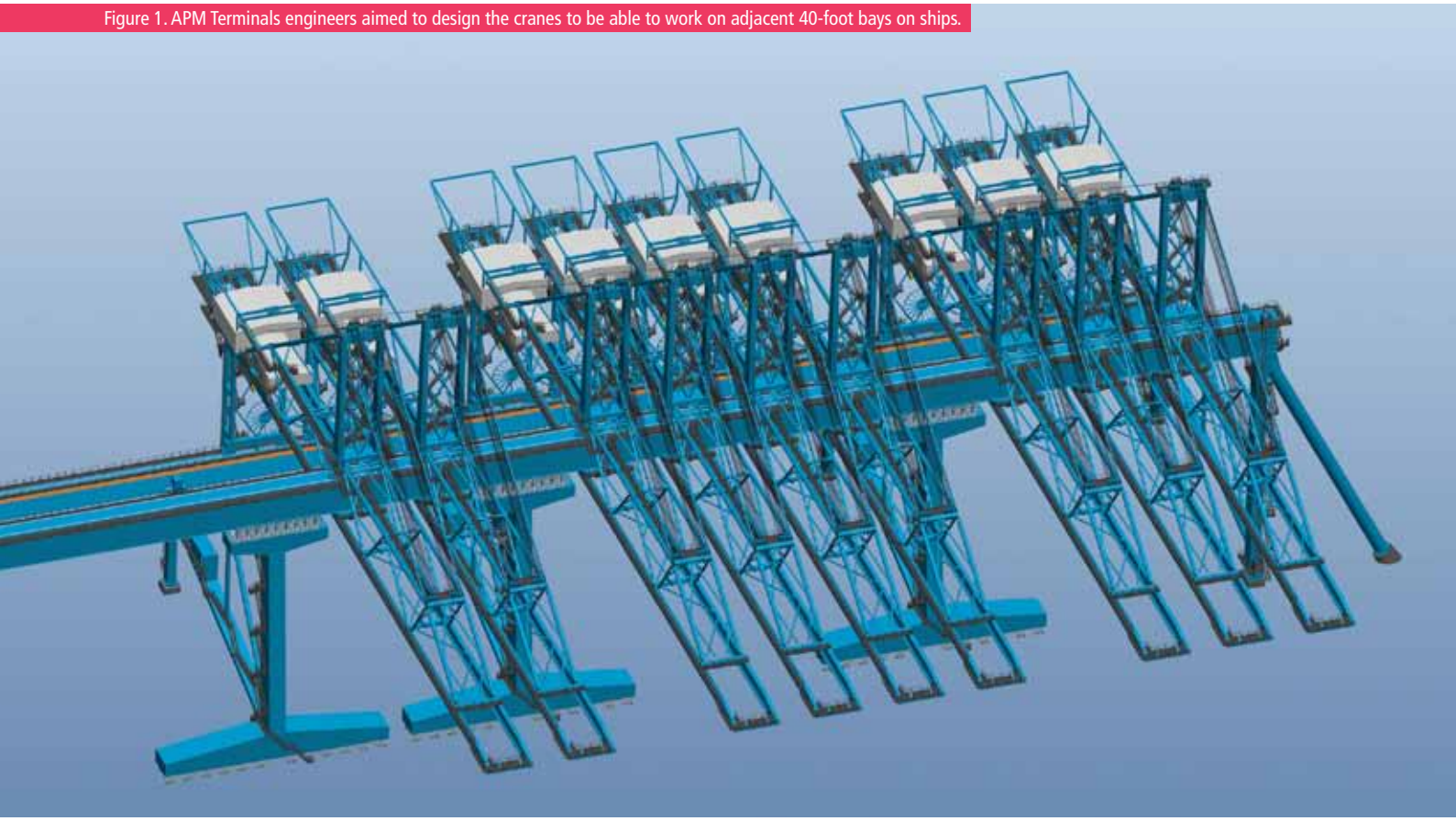
Dozens of ideas were generated, nothing was off-limits, and some of the ideas really pushed the boundaries of conventional thinking. Magnetic levitation may hold some promise in the future, but perhaps a bit more development is needed before it can be practical for terminal operations.

However, after some filtering of the ideas to focus on a concept that would deliver maximum customer benefit, one idea in particular stood out as having potential to deliver a quantum leap in service, and stood a reasonable chance of being 'do-able'.

Today's constraints are tomorrow's opportunities

Angelo de Jong, a young engineer working in APM Terminals' Innovation Department, had come up with an idea to eliminate the physical constraint imposed by the width of today's STS cranes, which makes it impossible for two cranes to simultaneously handle containers on adjacent 40-foot bays of a ship. This can be seen very clearly in Figure 1. This problem

Figure 1. APM Terminals engineers aimed to design the cranes to be able to work on adjacent 40-foot bays on ships.



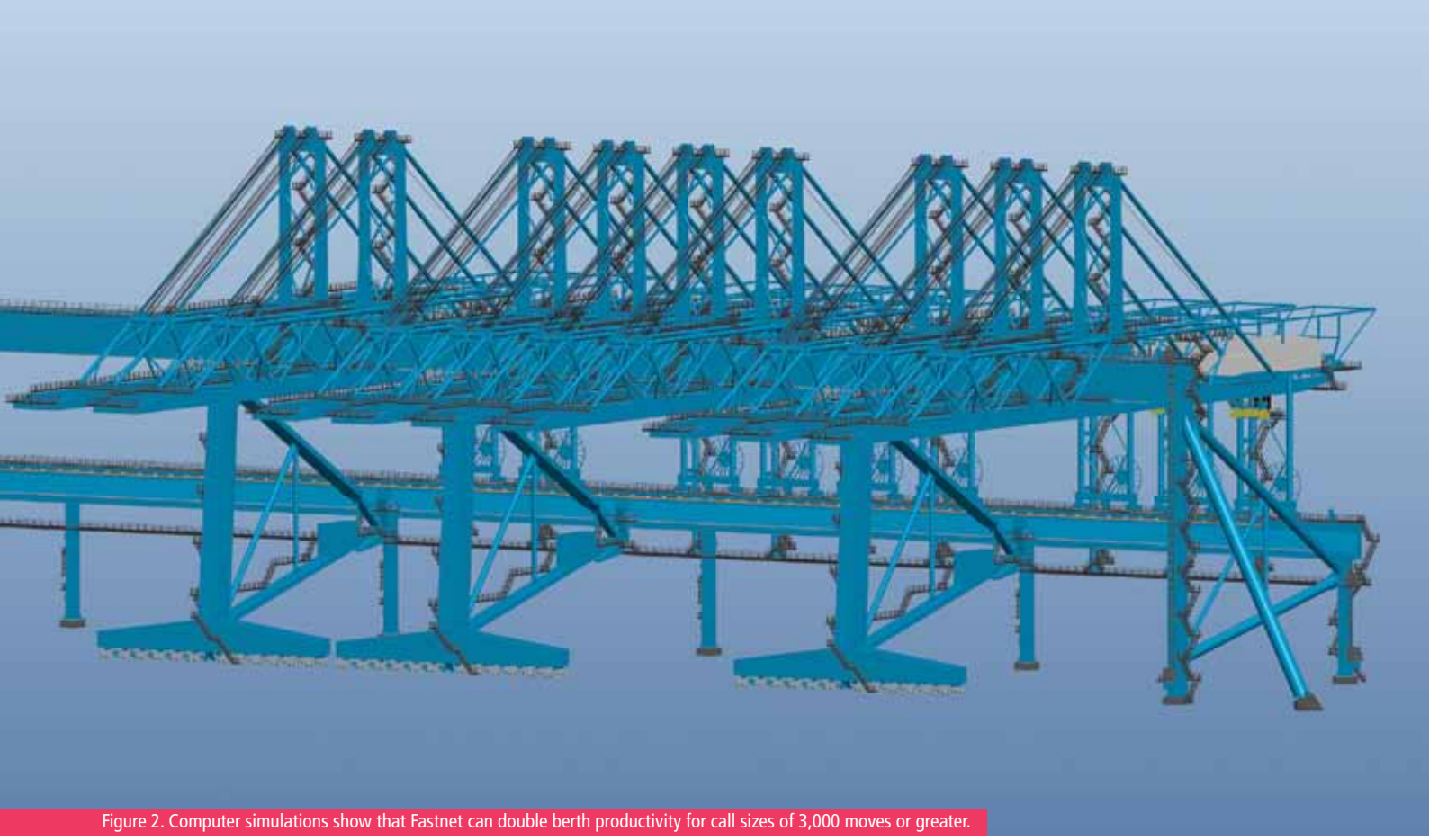


Figure 2. Computer simulations show that Fastnet can double berth productivity for call sizes of 3,000 moves or greater.

imposes a real physical limit on the maximum berth productivity that can be achieved with today's STS cranes.

The inability of conventional STS cranes to work on adjacent bays has to be taken into account by ship planners when planning loading and discharge sequences to avoid crane clashes. These clashes can occur even with very good planning if one crane works significantly faster or slower than another, or if a crane encounters an unexpected problem.

For several months after the Innovation workshop, a small team of APM Terminals engineering and operations experts developed the idea of an STS crane design where cranes ran along an elevated rail, enabling crane operations in adjacent bays, into an increasingly feasible concept.

In its early stages, the new crane structure was quite a bit heavier than existing STS cranes. This was a limitation, as the heavy structure meant the new crane design would only be suitable for placement on brand new, very strong, and therefore expensive quay walls. Designing a way for the elevated crane modules to travel past the support pillars was one of many critical features of the design, and a lot of ways that don't work were discovered on the way to finding optimum designs that we now know will work.

By mid-2008, the crane project had been extensively developed almost exclusively by internal resources, and it was showing a lot of promise. Considering the impact of perfecting the crane design, a project with significant funding was approved late in 2008 to enable further detailed development of the design, using leading industry crane and engineering consultants. Of course, late 2008 was a time of great financial turmoil. The global financial crisis resulted in every activity in our business coming under rigorous scrutiny. APM Terminals, however, is committed to driving innovation in the industry, and that requires a long-term focus – our management made the tough decision to stick with the crane development project in spite of the difficult financial situation.

A new crane concept – Fastnet

During the course of the project, now known as 'Fastnet', Angelo led a team of engineering experts to further enhance the internally developed design, prove that it would work, and that it could be built. In total 5,500 internal man hours, and more than 16,000 external man hours were devoted to reducing the weight of the crane structure, verifying structural requirements, designing control systems, ensuring the Fastnet operation would be safe and carrying out commercial analyses. Over 500 engineering drawings were produced and are now held on file.

Through clever design, the weight of the structure was significantly reduced to the point where the wharf loadings are now no higher than those imposed by conventional STS cranes. This development means that it is now feasible to retro-fit the new crane design on to any relatively modern container terminal wharf.

Detailed computer simulations of terminal operations were carried out, to ensure that currently available yard handling and horizontal transport systems could cope with the vastly increased rate of production possible with the new crane system.

Patented in 44 countries, Fastnet is a revolutionary development in STS crane design. Fastnet eliminates the productivity limitation imposed by the width of today's container cranes. The Fastnet crane eliminates this constraint by mounting the individual cranes on an elevated girder, supported by massive, movable pillars. The automated moveable pillars are controlled by a sophisticated management system, which will ensure that the individual cranes can always reach all of the bays on the ship. Extensive computer simulations have shown that for call sizes of 3,000 moves or greater, Fastnet can consistently double berth productivity from today's average of around 130 moves per hour to more than 270 moves per hour. Simulations have also shown that it is capable of delivering average berth productivity of 450 moves per hour.

The individual crane modules are quite similar to the top-sides of conventional STS cranes but, of course, without the wide

portal support frames. The 13.5-meter wide cranes are suspended under a massive elevated girder raised 50 meters above the wharf. The girder is supported by moveable pillars, which travel along a double waterside rail to spread the weight of the structure. A clever adaptation of technology used in bridge construction is used to distribute the loads equally across all of the wheels.

The 55-meter rail gauge provides ample room for the large numbers of horizontal transport units needed to keep up with productivity of more than 400 moves per hour.

Fixed supports for the elevated land-side rail facilitate easy access for traffic to and from the yard, and maintain an efficient flow under the cranes (multi-loop traffic flow) by eliminating the 'tunnel' effect, which occurs when a large number of conventional cranes are working close together.

Such a massive structure presents challenges in construction; hence the feasibility and logistics of constructing Fastnet were also investigated during the course of the project. We're satisfied that it can be built, and will operate as envisaged.

Fastnet is also scalable; while the support structures are obviously required from the first day of operation, we've established a process for adding cranes to the structure as needed in subsequent years.

Our studies show that Fastnet will generate the greatest overall supply chain benefits when implemented in terminals with frequent, high volume ship exchanges. Implementing Fastnet at terminals where the services calling have long sea voyages before or after the Fastnet call maximizes the opportunity to reduce ships' service speeds, thus creating opportunities to lower costs and reduce CO_2 emissions.

Maximum supply chain benefits will be generated when Fastnet is implemented in several terminals servicing the same string. Aggregated time savings generated at several Fastnet terminals might enable a reduction in the number of ships required to operate a service – generating major cost benefits.

A Fastnet berth, with its associated automated yard, represents a major capital investment. Our extensive commercial analyses of several potential locations for Fastnet berths show that the extremely high berth productivity possible can generate cost benefits for lines – but it's clear that such an significant investment needs to be well utilized in order to be commercially viable for a terminal operator.

So where are we likely to see Fastnet? Well, ultimately that depends on our customers. Fastnet is a solution that can double the current level of berth productivity for large ships. In the right locations, Fastnet presents an opportunity to dramatically reduce the time large container ships spend in port.

If our customers demand the sort of productivity that Fastnet can deliver, then APM Terminals has an extensively researched concept for the future, which is much more than just an idea.

ABOUT THE AUTHORS AND COMPANY

Ross Clarke holds the position of APM Terminals Head of Design & Operations for New Terminals. He is responsible for overseeing the operational design and specification of all of APM Terminals' new port and terminal developments. He is also responsible for identifying and developing new and innovative operational concepts for implementation in APM Terminals' new terminal developments.

Angelo de Jong has a background in Naval Architecture and joined APM Terminals as a Crane Engineer in 2005. After a management trainee program, he worked for two years in the R&D section of the global headquarters where he worked on FastNet and many other innovative solutions. He is now responsible for improving technical performance of container handling equipment in the terminals in the European region.

APM Terminals operates a global terminal network of 50 terminals with 22,000 employees in 34 countries that provide the port infrastructure essential to international transportation and global economic growth. The liner shipping industry, served by APM Terminals and other operators, carries US$4.6 trillion worth of international trade – approximately one third of the total value of global commerce.

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